Project Summary

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Dynamic Shear Strength of Gravelly Soils

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Background: WES geotechnical engineers have evaluated the seismic stability of several large, high-risk earth and rock fill dams in seismically active areas, many founded on loose gravel deposits, while advancing the state of the art and practice during the last two decades. The Geotechnical Laboratory has directed extensive programs of BPT/PDA explorations in support to seismic safety assessments of several Corps earth and rock fill dams during the last 10 years. The WES Soils Research Facility operates a unique collection of special, large-scale testing apparatuses for laboratory measurement of dynamic properties and strength of coarse soils, and is certified by the U.S. Department of Agriculture to receive and test soils from anywhere in the world. The WES Earthquake Engineering Research Program supports applied research to develop the BPT and other techniques as investigative tools for our customers. WES services and expertise can be secured and brought to bear on complex projects very quickly and at competitive costs through the Corps' existing funding stream.

Problem Statement: In situ material properties of soils containing gravels and cobbles, including inference of liquefaction resistance and residual strength, are currently estimated by converting Becker Hammer Penetration Test (BPT) blowcounts to equivalent Standard Penetration Test (SPT) blowcounts. BPT driving efficiency is strongly influenced by mechanical energy losses, including friction acting along the driven casing. Improved field procedures and data interpretation techniques are needed to evaluate in situ engineering properties of coarse-grained soils.

Objectives: The objectives of this study are: to develop and validate procedures to properly adapt penetration test results to estimate in situ cyclic and residual strengths of soils empirically, and to evaluate the adaptation of alternate in situ testing technologies for measuring in situ parameters needed for analysis, such as density or void ratio, to characterize dynamic strength.

Approach: The database of case histories on liquefaction occurrence in gravels and in situ testing experience has been studied to evaluate gradational constraints (i.e., limiting gravel content) on performance and interpretation of penetration tests. Laboratory pressure chamber tests were conducted to assess effects of gradation, density, and confining pressure on penetration resistance in sands and gravels. Field studies have been performed at a liquefaction site in gravels, including penetration experiments using various type and size hammers, penetrometers, and samplers, for which driving energy was measured during all tests; crosshole and downhole shear wave velocity surveys were completed during September 1999.

Results and Products Expected: This research will produce the following products that are of immediate value on projects where dynamic strengths must be determined in situ:

- Quantification of casing friction and equipment variability effects
- Guidelines for performance of BPTs, SPTs, and large penetrometer tests (LPTs) in gravels
- Procedures for evaluating penetration test results, with particular application to liquefaction potential evaluation in situ, and ultimately
- New procedures for measurement of density and void ratio in gravel deposits.

The likely benefits of performing this study include reduced uncertainty, reduced costs of remediation on projects where earthquake-induced strength loss is indicated, and improved techniques for in situ determination of valuable engineering parameters.

For more information about dynamic shear strength of soils and their pore pressure generation characteristics applied to seismic stability evaluations of dams or for other geotechnical earthquake engineering applications, contact Dr. Joseph P. Koester, CEERD-GG-H, (601) 634-2202 or e-mail koestej@wes.army.mil.